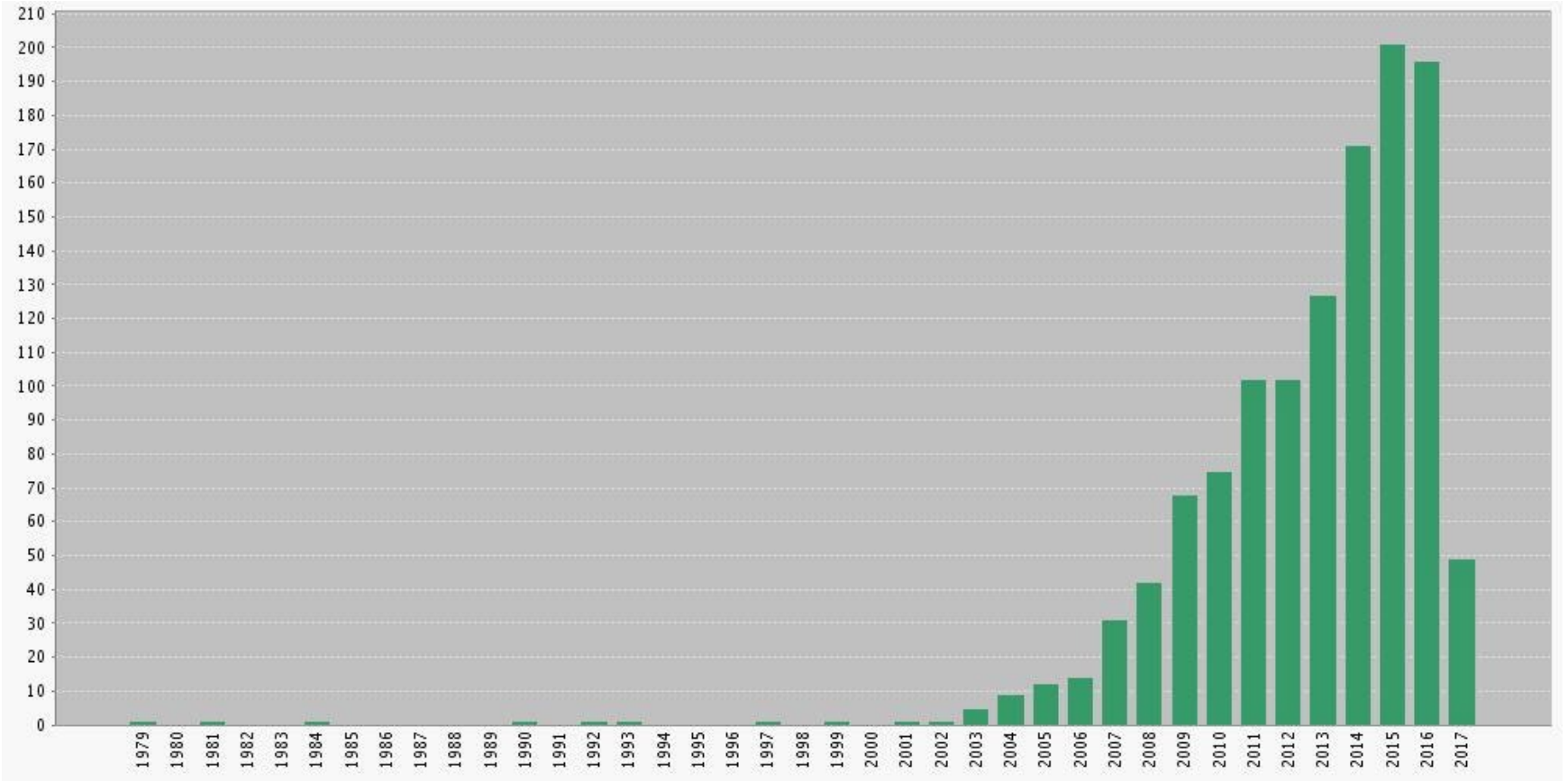
Computer modeling of physical phenomena

Lab IV – Zachary's Karate Club

A dormant paper...

Wayne W. Zachary, An Information Flow Model for Conflict and Fission in Small Groups
Journal of Anthropological Research Vol. 33, pp. 452-473, 1977



The story (1)...

THE ETHNOGRAPHIC RATIONALE

The karate club was observed for a period of three years, from 1970 to 1972. In addition to direct observation, the history of the club prior to the period of the study was reconstructed through informants and club records in the university archives. During the period of observation, the club maintained between 50 and 100 members, and its activities included social affairs (parties, dances, banquets, etc.) as well as regularly scheduled karate lessons. The political organization of the club was informal, and while there was a constitution and four officers, most decisions were made by concensus at club meetings. For its classes, the club employed a part-time karate instructor, who will be referred to as Mr. Hi.[2]

At the beginning of the study there was an incipient conflict between the club president, John A., and Mr. Hi over the price of karate lessons. Mr. Hi, who wished to raise prices, claimed the authority to set his own lesson fees, since he was the instructor. John A., who wished to stabilize prices, claimed the authority to set the lesson fees since he was the club's chief administrator.

As time passed the entire club became divided over this issue, and the conflict became translated into ideological terms by most club members. The supporters of Mr. Hi saw him as a fatherly figure who was their spiritual and physical mentor, and who was only trying to meet his own physical needs after seeing to theirs. The supporters of John A. and the other officers saw Mr. Hi as a paid employee who was trying to coerce his way into a higher salary. After a series of increasingly sharp factional confrontations over the price of lessons, the officers, led by John A., fired Mr. Hi for attempting to raise lesson prices unilaterally. The supporters of Mr. Hi retaliated by resigning and forming a new organization headed by Mr. Hi, thus completing the fission of the club.

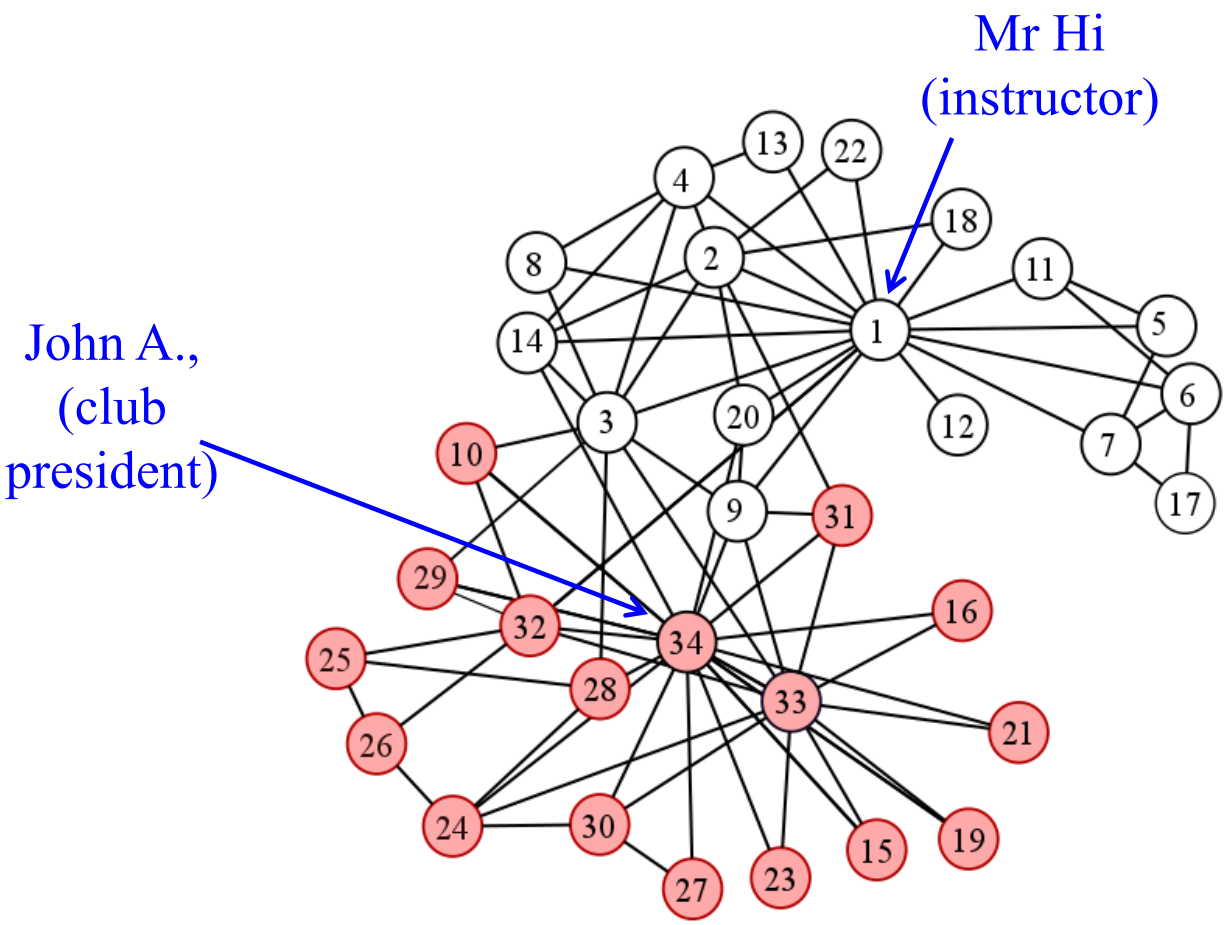
The story (2)

During the factional confrontations which preceded the fission, the club meeting remained the setting for decision making. If, at a given meeting, one faction held a majority, it would attempt to pass resolutions and decisions favorable to its ideological position. The other faction would then retaliate at a future meeting when it held the majority, by repealing the unfavorable decisions and substituting ones favorable to itself. Thus, the outcome of any crisis was determined by which faction was able to "stack" the meetings most successfully.

The factions were merely ideological groupings, however, and were never organiztionally crystallized. There was an overt sentiment in the club that there was no political division, and the factions were not named or even recognized to exist by club members. Rather, they were merely groups which emerged from the existing network of friendship among club members at times of political crisis because of ideological differences. There was no attempt by anyone to organize or direct political strategies of the groups, and, in general, there was no barrier to interaction between members of opposing factions. Only at times of direct political conflict did individuals selectively interact with others who shared the same ideological position, to the exclusion of those holding other positions. This selective association during confrontations is what brought the factions together only at crisis moments.

Political crisis, then, also had the effect of strengthening the friendship bonds within these ideological groups, and weakening the bonds between them, by the pattern of selective reinforcement. A series of political crises, like that which preceded the fission had the effect of "pulling" apart the network of friendship ties which held the club together, until the group completely and formally separated.

The network


Mr Hi
(instructor)
John A.,
(club
president)
13
22
4
18
8
2
11
14
1
5
6
3
20
12
7
10
9
31
17
29
16
32
34
25
28
33
21
26
24
30
15
19
27
23

Links based on..

(1) Association in and between academic classes at the university.

(2) Membership in Mr. Hi's private karate studio on the east side of the city where Mr. Hi taught nights as a part-time instructor.

(3) Membership in Mr. Hi's private karate studio on the east side of the city, where many of his supporters worked out on weekends.

(4) Student teaching at the east-side karate studio referred to in (2). This is different from (2) in that student teachers interacted with each other, but were prohibited from interacting with their sutdents.

(5) Interaction at the university rathskeller, located in the same basement as the karate club's workout area.

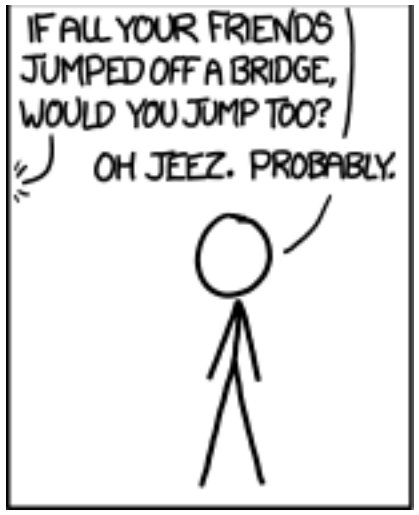
(6) Interaction at a student-oriented bar located across the street from the university campus.

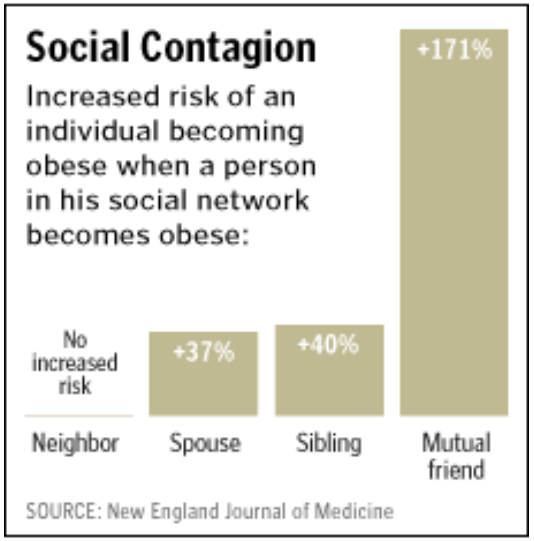
(7) Attendance at open karate tournaments held through the area at private karate studios.

(8) Attendance at intercollegiate karate tournaments held at local universities. Since both open and intercollegiate tournaments were held on Saturdays, attendance at both was impossible.

Homophily & heterophobia

- homophily - people tend to connect those who are similar to themselves
- heterophobia - we lose contact with people of other views
- social contagion - people tend to become more similar to their social neighbors over time.





Adaptive diffusion model

- Each node carry a state: $c \in [0,1]$, encoding association with a particular fraction (Mr Hi =1, John. A = 0 all the time, the others are initiated with c=0.5)
- Each edge is undirected and has a weight, $w \in [0,1]$, which represents the strength of the connection. Weights are initially set to 0.5 for all the edges.
- The diffusion of the node states occurs according to:

$$\frac{dc_i}{dt} = D\sum_{j\in N_i}\left(c_j - c_i\right)w_{ij}$$

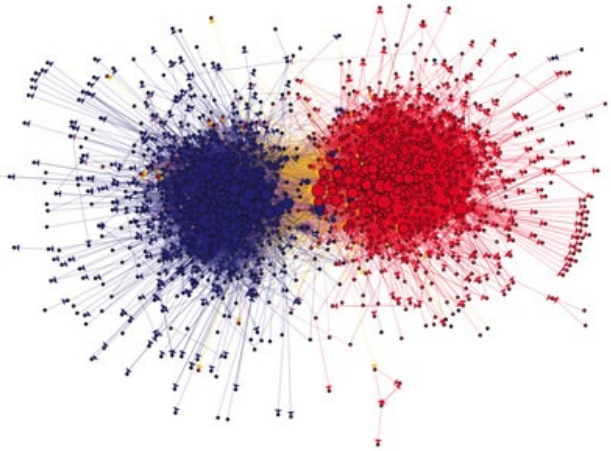
where D is the diffusion constant and w_{ij} is the weight of the edge between node i and node j (diffusion is faster through edges with greater weights)

- Each edge also changes its weight dynamically:

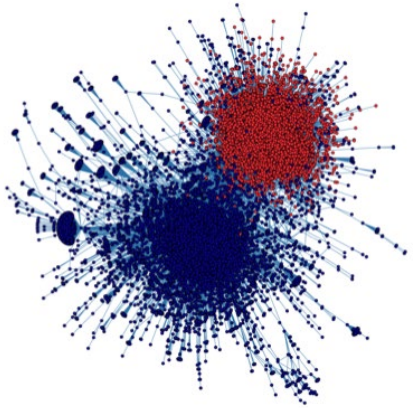
$$\frac{dw_{ij}}{dt} = -\beta w_{ij}(1-w_{ij})f(\left|c_i - c_j\right|) \qquad f(x) = (x-0.25)^3$$

Divided we stand...

- With time, the evolving topology of the network can result in its division in two disjoint compounds



US blogosphere 2004



US Twitter 2011

Your task

- Run adaptive diffusion algortihm on Zachary's karate club network
- Try D=5, beta=10, take at least dt=0.01 for a timstep, if using Euler update
- Does the network divide in two components? If so, what are these components? How do they compare with the real division that took place in this club (fractions marked by colors in the network graph above)
- Which node or nodes survive the longest as the bridge between the two groups?

Some hints

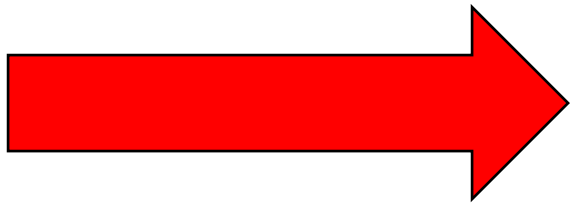
- attributes: add the attribute 'state' to the nodes and 'weight' to the edges
- parallel update - create a copy of the network (nextg) to update all the nodes at once
- spring layout - best to visualize the division of the network, as it automatically takes into account the weights of the edges (if the attribute 'weight' is used)
- iterators: use g.nodes, g.edges to loop through the nodes or edges
- plotting:

```
nx.draw_spring(g, cmap = cm.cool, vmin = 0, vmax = 1,with_labels = True, node_color = [g.nodes[i]['state'] for i in g.nodes_iter()], edge_cmap = cm.binary, edge_vmin = 0, edge_vmax = 1,edge_color = [g.edge[i][j]['weight'] for i, j in g.edges])
```

- plot the network every 10 timesteps to create a movie illustrating its division

Extra task

- Can you improve the predictions of the members' division between the groups by using the extra information from Zachary's paper on strengths of connections between the members?



QUANTIFIED MATRIX OF RELATIVE STRENGTHS OF THE RELATIONSHIPS IN THE KARATE CLUB: THE MATRIX *C*

Individual Number

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	0	4	5	3	3	3	3	2	2	0	2	3	2	3	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	2	0	0
2	4	0	6	3	0	0	0	4	0	0	0	0	0	5	0	0	0	1	0	2	0	2	0	0	0	0	0	0	0	0	2	0	0	0
3	5	6	0	3	0	0	0	4	5	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	3	0
4	3	3	3	0	0	0	0	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	3	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	3	0	0	0	0	0	5	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	2	4	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	4	3
10	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
11	2	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	3	5	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4
17	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
20	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
22	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
28	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
29	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
31	0	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
32	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
33	0	0	2	0	0	0	0	0	3	0	0	0	0	0	3	3	0	0	1	0	3	0	2	5	0	0	0	0	0	0	4	3	4	5
34	0	0	0	0	0	0	0	0	4	2	0	0	0	3	2	4	0	0	2	1	1	0	3	4	0	0	2	4	2	2	3	4	5	0

http://www.fuw.edu.pl/~piotrek/compl2022/zachary.txt